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AUTHOR Campbell, George, Jr.
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ABSTRACT

The substantial gender gap in the science and engineering professions becomes even greater from the perspective of women in underrepresented minority groups. This document analyzes data on university enrollment and graduation by both gender and ethnicity compiled by the National Action Council for Minorities in Engineering (NACME). Findings indicate that engineering and physics persist as the most exclusively male-dominated among science-based disciplines and that minority women remain the most underrepresented group in engineering. Constituting 15% of the college-age population in 1994, minority women comprised only 2.2% of the bachelor's graduates and a mere 0.3% of the Ph.D.'s. In addition, freshman enrollment of minority women declined 12.1% between 1992 and 1994. Other findings include: major inhibiting factors begin very early in minority womens' educational experience and few graduate from high school with the necessary prerequisites to pursue engineering in college; minority women who perform well in mathematics and science disproportionately opt out of the pipeline before entering college; and those who go on to major in engineering have the highest attrition rate. It is concluded that failure to solve the attrition problem stems partially from an overemphasis on the student deficit model and underemphasis on institutional deficiencies. (JRH)

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ED 401 108

Bridging the Ethnic and Gender Gaps in Engineering

by
George Campbell Jr., Ph.D.

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NACME

May 1996 Volume 5, Number 1

Research Letter

Bridging the Ethnic and Gender Gaps in Engineering

George Campbell Jr., Ph.D.

Highlights

- In virtually all science-based disciplines except physics and engineering, the participation of women has grown steadily since the early 1970s and is now approaching parity. In physics and engineering, the number of women reached a plateau at about 15 percent where it has remained for over a decade. This suggests the presence of attributes in the social construction of these male-dominated fields that inhibits further progress of women.
- Among all population groups, minority women have the lowest participation rates in engineering. Constituting about 15 percent of the college-age population in 1994, they comprised only 2.2 percent of the annual B.S. graduates, 1.1 percent of the M.S. graduates and 0.3 percent of the Ph.D. graduates.
- A majority of American children (about 60 percent) and the bulk of minority children (about 85 percent) are channeled out of academic mathematics and science when they are only 13 years old.
- Differences between high school boys and girls in expressed interest in mathematics and science, in mathematics and science enrollment and in academic performance are insufficient to account for the gender gap at the university level, where men are 4.5 times more likely to choose engineering as a major. Other socialization processes are at work both inside and outside the classroom.
- Seventy-five percent of minority women graduates are produced by just 20 percent of the nation's engineering colleges. Half of the colleges produce no more than one minority woman graduate per year on average.

continued on page 3

Introduction

The substantial gender gap in the science and engineering professions becomes even greater from the perspective of women from underrepresented minority groups. Aggregating the American population by both ethnicity and gender, we find that Latinas, African American women and American Indian women have by far the lowest participation rates. Unfortunately, social science research and practice have conventionally treated minorities and women as orthogonal groups, neglecting the fact that half of minorities are women who are deeply affected by gender, as well as racial, biases in our society. Many databases available to the research community do not even contain the necessary information to permit a disaggregation of women by ethnicity. The rich array of programs in science, mathematics and engineering that have been developed over the past twenty years to serve minority groups are often detached from women's issues, and those that serve women are typically disconnected from ethnic discrimination issues. The circumstances that result from disregarding the specific issues faced by minority women is exacerbated by the myth that, as members of two affirmative action categories, they have a distinct advantage.

A principal objective of ongoing research at NACME is to characterize and understand better the double-bind phenomena — those unique issues that differentially inhibit minority women's access to careers in the science-based disciplines. In engineering, the most comprehensive database on minority participation available is compiled annually by the Engineering Workforce Commission (EWC) under a grant from NACME. In 1990, we began to collect the information on university enrollment and graduation by both gender and ethnicity, and the five years of data we have now accumulated form the basis for the analysis herein.

Minorities and Women: Two Decades of Progress?

To provide a framework for the discussion of minority women, it's useful first to examine enrollment and graduation data in the context of the overall progress of women and minorities since the early 1970s, when simultaneous, though distinct, national efforts to increase their respective participation in engineering began in earnest. Data from the 1950s to the present time show that, prior to 1972, women never comprised more than one percent of the engineering graduates annually.[1] During the

George Campbell Jr., Ph.D., is president and CEO of NACME, Inc.

Figure 1.

Women Engineering Graduates

1970-1994

Figure 2.

Women SEM Graduates, BS

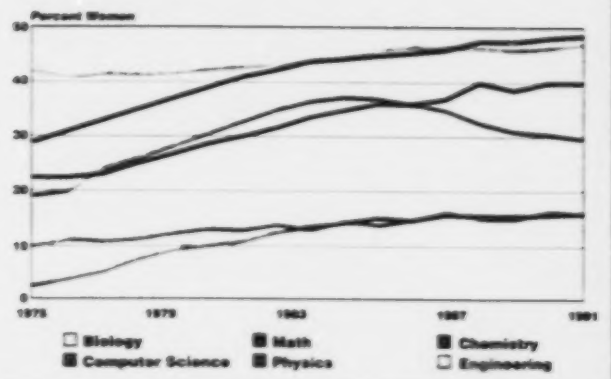


Figure 3.

Women Engineering Graduates, 1994

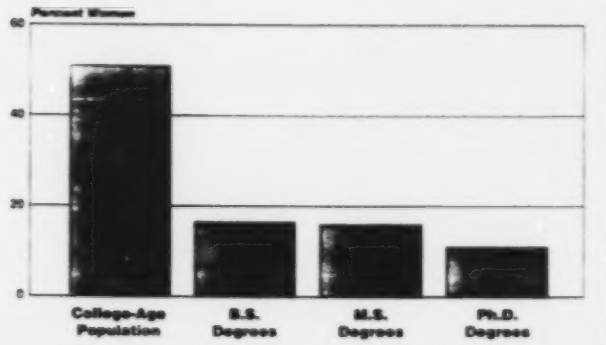


Figure 4.

Minority Engineering Graduates

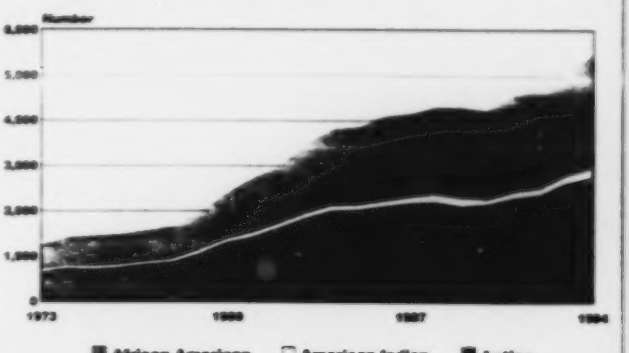


Figure 5.

Minority Engineering Graduates, 1994

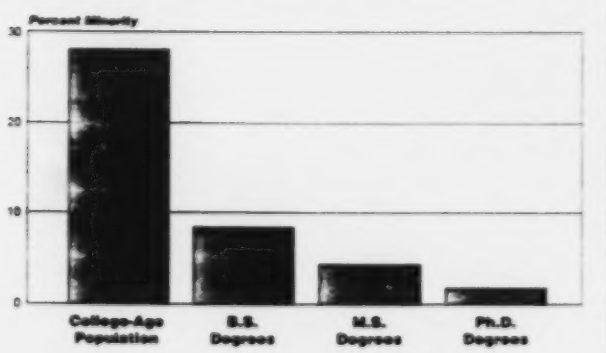
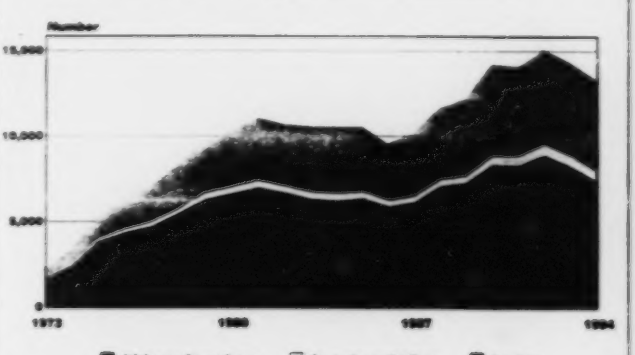


Figure 6.

Freshman Engineering Enrollment, Minorities



ensuing decade, the number grew rapidly, but suddenly and enigmatically reached a plateau centered around 15 percent (Figure 1). This unanticipated situation remains intriguing, in part, because it's quite specific to engineering and physics. Virtually all of the other scientific disciplines show continuing progress toward parity, well beyond 15 percent, though fluctuations are present (Figure 2).[2] This suggests the presence of influences and values in the social construction of physics and engineering — disciplines with perhaps the most male-oriented culture — that continues to resist the development of a critical mass of women.

The best measure of progress towards parity, which we use throughout this paper, is participation rate relative to population distribution.[3] Viewing the 1994 data on degree attainment this way (Figure 3), we see that the number of women who received bachelor's degrees was only one-third of what we would expect, based on population distribution. At the Ph.D. level, the number of women should be 4.6 times higher.

The 1970s also marked a rapid increase in minority graduates (of both genders) in engineering, which has continued to the present time (Figure 4). The 1994 figure of 5,490 minority graduates represents an order of magnitude increase relative to 1971. No other profession has shown comparable growth, and it's gratifying for us to note the role of NACME in the progress minorities have made. For example, ten percent of all African American, Latino, and American Indian engineering graduates since the late 1970s went through college with NACME scholarships. In spite of steady progress, however, parity remains a distant goal. Underrepresented minorities now comprise 28 percent of the college-age population and 40 percent of the birth rate, yet generated only 8.5 percent of the bachelor's graduates in 1994 and a dismal 1.8 percent of the Ph.D.s (Figure 5). While we don't believe in quota systems, preferential treatment or any of the other attributes incorrectly associated with affirmative action, clearly, if our society is going to be successful, we must improve those numbers in a field as important to the national economy as engineering.

We note with uncertain significance that, though the progress of minorities has not reached a plateau, this population group also has not quite attained the relative participation level that women have achieved. Moreover, data for the past two years present an early warning sign, as minority freshman enrollment in engineering declined sharply from 15,181 to 13,375, a drop of almost 12 percent (Figure 6). Among African Americans, the decline was even more dramatic, from 8,924 to 7,372, or more than 17 percent.

Minority Women in Engineering

As noted earlier, data on the participation of minority women and the issues inhibiting their participation are not well-understood. In addition, the data we do have is often interpreted incorrectly. A common misrepresentation occurs in comparing minority and nonminority women with male peers from their respective groups (Figure 7). Minority women in 1994 constituted 26.1 percent of the minority graduates, while nonminority women were only 15.6 percent of the nonminority graduates. But because minority men are substantially underrepresented, this does not mean that minority women fared better than nonminority women — quite the contrary. Figure 8 shows that minority women comprised only 2.2 percent of the total bachelor's degrees in engineering, 1.1 percent of the Master's degrees and 0.3 percent of the Ph.D.s, while constituting almost 15 percent of the college-age population.

The above example illustrates the importance of using the correct basis for comparing statistics on participation. Formalizing the measure of representation alluded to in the Introduction, we define the Engineering Participation Factor (EPF) as the ratio of percent of engineering graduates to percent of college-age population.[4] The EPFs, given in Table I, clearly demonstrate the fact that minority women are by far the most significantly underrepresented population group in engineering. And recent enrollment trends reflect the declines noted above for the minority population as a whole. Freshman enrollment for minority women dropped 12.1 percent from the peak of 4,381 in 1992 to 3,851 in 1994 (Figure 9). Again the decline was greatest for African American women: from 2,918 to 2,455 or 15.9 percent.

Highlights, *continued from page 1*

- There are significant differences among women from different ethnic groups with respect to subdiscipline preferences in engineering.
- In the context of the social struggle for equity, minority women exhibit a stronger identification with issues of race and ethnicity than with gender issues, and they appear to be better supported by minority programs than by women's programs.
- The retention of minority women in engineering is about half that of nonminorities and eight percent less than that of minority men.
- The current withdrawal from affirmative action programs, including minority scholarships, has been accompanied by what amounts to an affirmative action program for the wealthy. Universities can improve their net tuition revenues by giving scholarships to wealthy students who may have lower qualifications, but who can pay the bulk of their expenses in cash. Students with greater financial need are left to draw on loan programs, often with devastating consequences. Statistics show that a shift of $1,000 from scholarship to loan support yields a 17 percent decline in retention.
- Failure to solve the attrition problem stems, in part, from an overemphasis on the student deficit model and underemphasis on institutional deficiencies.

Table I
Engineering Participation Factor, Percent of Parity, 1994
B.S. Degrees in Engineering

Population Group	Men	Women	Total
Total	170	32	100
Nonminorities	214	39	127
Minorities	45	16	31
African Americans	41	18	28
Latinos	56	14	33
American Indians	N/A	N/A	N/A

Factors Inhibiting Access

Many factors that inhibit access to science-based careers are not unique to minorities, but the legacy of discriminatory practices yields a disproportionate impact on those populations. Only 12 percent of American students — both genders, all ethnic groups — graduate from high school with credits in the traditional prerequisites for an undergraduate major in engineering. Among minority students, however, only six percent complete the necessary mathematics sequence through at least pre-calculus and the science sequence that includes chemistry and physics (Figure 10).[5] Considering the fact that many of our competitor nations of the Far East, and even the newly independent countries of Eastern Europe, require all high school students to complete calculus and physics, our numbers portend severe consequences for our long term economic competitiveness and social stability. The issue goes well beyond career choice and equity. Entry level jobs in a modern factory require understanding of graphical analysis, statistical sampling, sophisticated measuring techniques or the ability to operate computer-controlled machines. Thus many of our high school students are not being prepared to enter the workforce in any capacity.

What accounts for the dearth of high school students in academic mathematics and science courses and for the differential participation rates of minorities and nonminorities? Some causes are fundamental to the approach to education in this country. Deeply rooted in the American system and in the belief structure of educators is that students must have a somewhat rare, innate ability in order to learn higher level mathematics — the "math gene." At the same time, few cognitive theorists would disagree with the fact that all physiologically normal children, with sufficient motivation and effective learning strategies, can master the ideas and applications that constitute high school calculus and physics curricula. Unfortunately, we have far fewer qualified teachers than we need in the advanced mathematics and science areas, even to meet the current demand, and those who are qualified are disproportionately located in nonminority communities. Moreover, the processes used to select those students who have the presupposed mathematics ability are, somehow, far less likely to choose either poor students or students from underrepresented minority groups. Consequently, a majority of American students (about 60 percent) and the bulk of minority students (about 85 percent) are channeled out of academic mathematics and science when they are about 13 years old.

Perhaps a simpler problem to deal with is that many students, themselves, are making uninformed decisions when they select or accept their high school courses. Too many parents do not understand that when their children are assigned to "consumer math" or "general science," they are essentially foregoing a wide range of future career possibilities, including those, such as engineering, which offer the greatest opportunities. Many students who have career aspirations that require a degree in engineering or science have opted out of academic mathematics early in their high school experience. This is illustrated in Figure 11, which shows one result of a survey commissioned by NACME and carried out by Louis Harris and Associates in connection with our *Math Is Power* national advertising campaign.[6] Campaign objectives are to inform parents and students about the importance of mathematics and science, to stimulate policy changes that lead to higher level requirements and, ultimately, to get more students to successfully complete academic mathematics and science courses. One anomalous result of the study, which included oversampling of minorities to ensure statistically significant results, is that fewer girls than boys believe themselves to be discouraged in mathematics and science (Figures 12 and 13). More girls than boys express an interest in advanced mathematics and science courses (Figure 14). Physics is the only course in which there is an appreciable gap (Figure 15).[7] Yet, the college choice of major shows a dramatic gender difference, particularly in engineering, as men are 4.5 times more likely to choose an engineering major — 4 percent for first year women vs. 18 percent for first year men (Figure 16). Some studies have suggested that, while girls do as well boys in mathematics and science at the high school level, the socialization processes that take place both inside and outside of class do, in fact, discourage girls from further pursuits.[8]

Subdiscipline Preferences

Figure 17 shows that there are also significant differences among women from different ethnic groups with respect to subdiscipline preferences in engineering. Among nonminorities in 1994, for example, electrical engineering was the preferred discipline, followed by civil, mechanical and then chemical. For minority women, electrical was again the favorite choice, but that was followed by mechanical and chemical — virtually tied — and then civil. Among African Americans, more women than men graduate with degrees in chemical engineering. This cannot be totally explained by the dearth of African American men. Looking at the statistics somewhat differently, women comprised a larger fraction of the bioengineering graduates (31.3 percent) than of any other field, with chemical engineering a close second (30.3 percent). For minority women, on the other hand, industrial/systems

Figure 7

Women Engineering Graduates

1994 BS Degrees

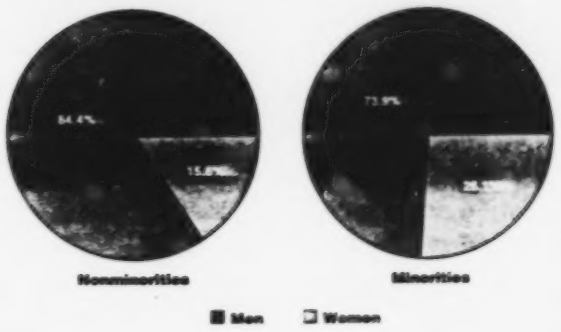


Figure 8

Minority Women Engineering Graduates, 1994

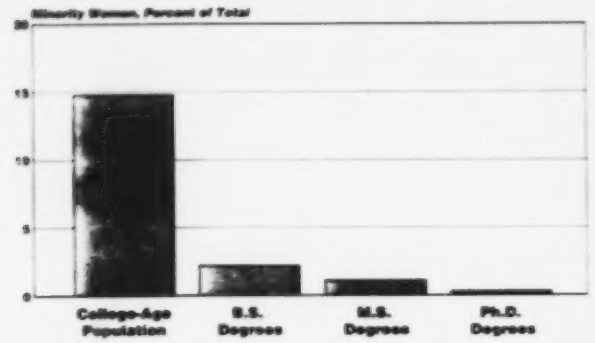


Figure 9

Minority Women

Freshman Enrollment, 1992-1994

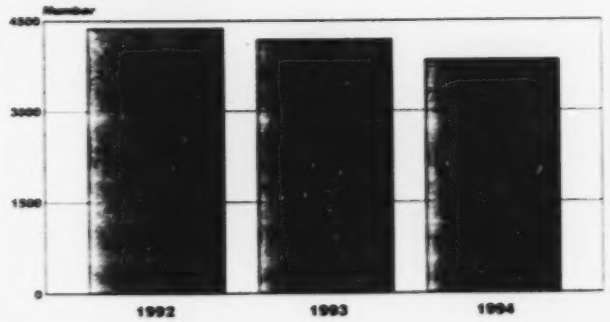


Figure 10

HS Course Completion

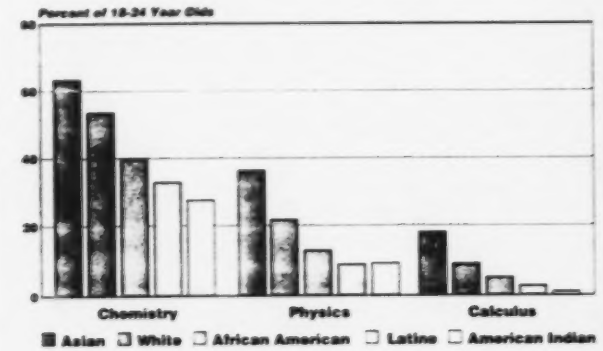


Figure 11

Career Interests

Students Planning to Drop Math

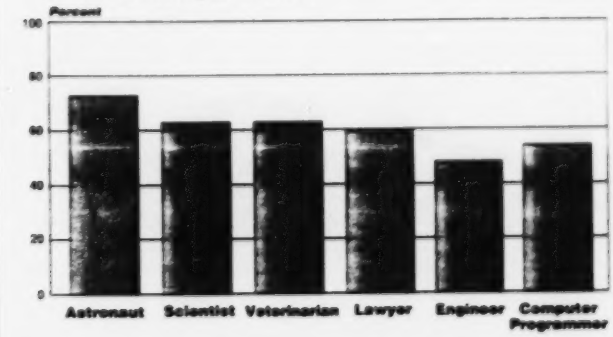
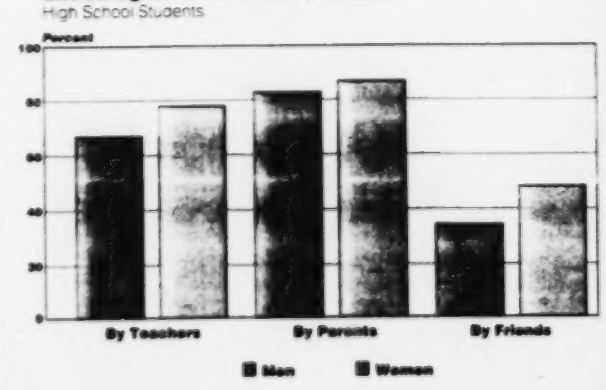


Figure 12

Encouraged in Math and Science

High School Students



engineering is first, followed by chemical. Fully understanding this combination of ethnic and gender differences, as seen in Figures 16 and 17, remains an area for further research. In particular, examining the subdisciplines that are most attractive to minority women and to women from other groups, might offer some useful insights into the access and retention issues.

Table II
Top 35 Universities Ranked by Number of Minority Women Graduates in Engineering, 1994

University	Minority Women Graduates
North Carolina A&T State University*	72
Georgia Institute of Technology	55
Prairie View A&M University*	53
Tuskegee University*	49
Howard University*	39
Texas A&M University §	32
North Carolina State University at Raleigh	30
California State University at Long Beach	25
Florida International University §	25
Purdue University	22
University of Michigan	22
University of Texas at Austin	22
Massachusetts Institute of Technology	22
Clemson University	22
Southern University*	21
Florida A&M*/Florida State Universities	19
Michigan State University	18
Morgan State University*	17
University of Florida	16
Stanford University	16
Tulane University	15
University of Alabama	15
California Polytechnic, San Luis Obispo	15
University of Texas at El Paso §	15
University of New Mexico §	14
Cornell University	14
University of Miami	13
New Mexico State University §	13
University of Delaware	13
City College of New York §	11
New Jersey Institute of Technology	11
Northwestern University	11
Rensselaer Polytechnic Institute	11
Tennessee State University*	11
University of California at Los Angeles	11

* Historically Black College or University
§ Hispanic Association of Colleges and Universities Member

Table III
Top 35 Universities Ranked by Percent Minority Women Among Engineering Graduates, 1994

University	Percent Minority Women Among Graduates
Tuskegee University*	43.4
Howard University*	41.5
NC A&T State University*	33.8
Prairie View A&M University*	32.5
Southern University*	29.2
Morgan State University*	27.9
Tennessee State University*	15.7
Florida International University §	11.4
University of Texas at El Paso §	11.1
Tulane University	9.9
Florida A&M*/Florida State Universities	8.6
University of Miami	8.3
University of Delaware	7.3
University of Alabama	6.9
University of New Mexico §	6.4
New Mexico State University §	5.4
California State University at Long Beach	4.8
Northwestern University	4.6
California State University at Northridge	4.5
Georgia Institute of Technology	4.5
Stanford University	4.4
Clemson University	4.2
Washington University	3.9
Massachusetts Institute of Technology	3.4
City College of New York §	3.4
New Jersey Institute of Technology	3.0
University of Virginia	3.0
Michigan State University	2.9
University of Tennessee at Knoxville	2.9
Texas A&M University §	2.9
University of Texas at Austin	2.7
University of Florida	2.6
North Carolina State University at Raleigh	2.5
University of California at Los Angeles	2.5
University of Michigan at Ann Arbor	2.4

* Historically Black College or University
§ Hispanic Association of Colleges and Universities Member

Successful Institutions

To determine what strategies and practices are effective in creating access, another approach is to identify the attributes of those universities that have been most successful at graduating minority women. This work is in progress at NACME and, while we do not yet have definitive conclusions, we report here some preliminary data that suggest promising directions. Table II lists the top 35 universities producing minority women engineering graduates in 1994. Clearly, few colleges graduate significant numbers. Only twenty percent of the nation's engineering colleges produced 75 percent of the minority women graduates during the three academic years 1991-92, 1992-93 and 1993-94 (Figure 18), and half of the colleges produced no more than one per year on average. Table III lists the top 35 universities by percent of minority women in the 1994 graduating class.

Figure 19 shows what fraction of minority women graduate from universities characterized as public, private, research institutions, Historically Black Colleges and Universities (HBCU) or members of the Hispanic Association of Colleges and Universities (HACU), and *U.S. News and World Report's* Top 25 — obviously not a mutually exclusive list. Normalized to the size of the institutions, e.g., total fraction of engineering graduates produced, also shown in the figure, only the two groups categorized as HBCU/HACU or private institutions produce more than their expected share of the small number of total minority women engineering graduates.

An interesting question one might ask is, "What are the attributes of the student bodies at institutions minority women choose, recognizing that the selection process takes place while they are still in high school?" Though not conclusive, Figures 20 and 21 show that there is a significantly higher correlation with the total number of minorities than with the number of women in the student population. This is consistent with the perspective, reported elsewhere, that, in the context of the social struggle for

Figure 13.

Discouraged in Math and Science

High School Students

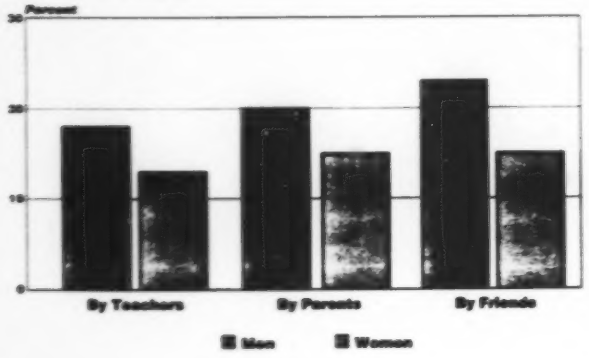


Figure 14.

Interest in Advanced Courses

High School Students

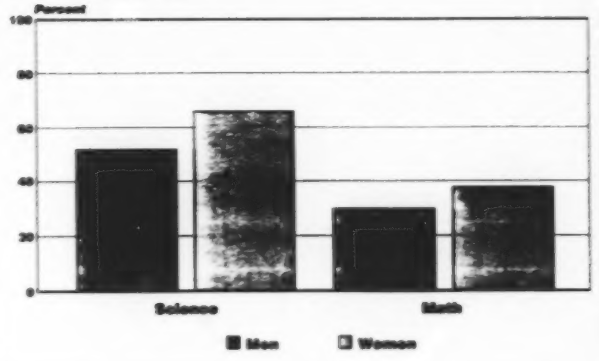


Figure 15.

High School Course Completion

Gender Differences

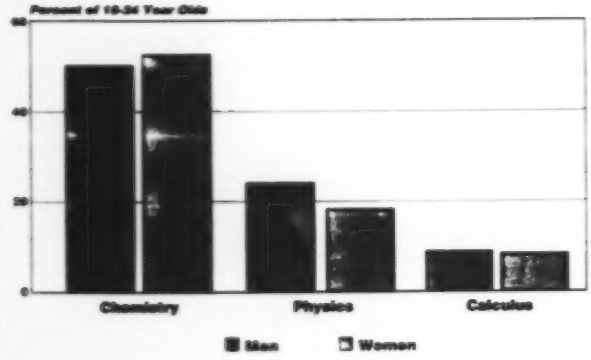


Figure 16.

Choice of Engineering Major

First Year Women

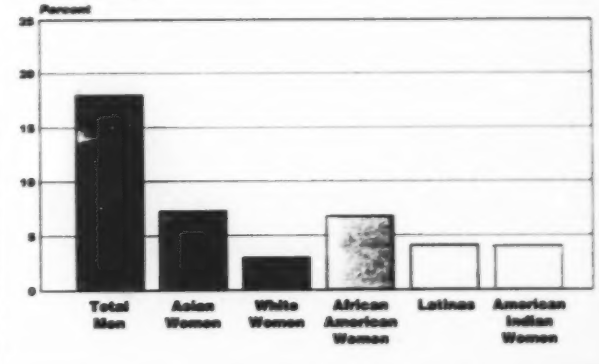


Figure 17.

Preferred Subdisciplines

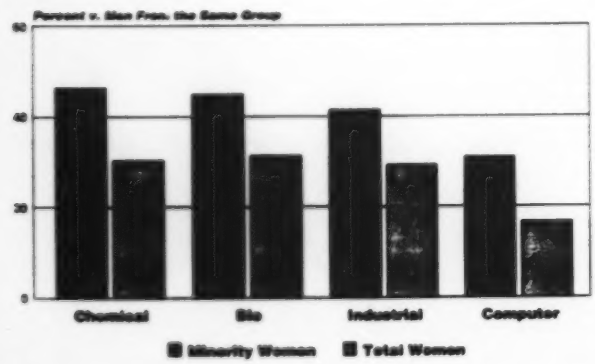


Figure 18.

Minority Women Graduates

Cumulative Distribution, Average 1991-94

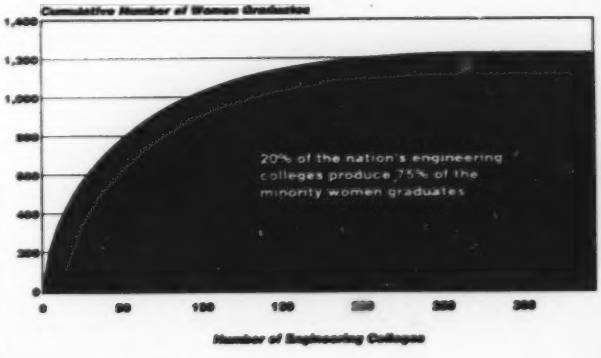


Figure 19.

Producing Minority Women Engineers

1994 BS Graduates

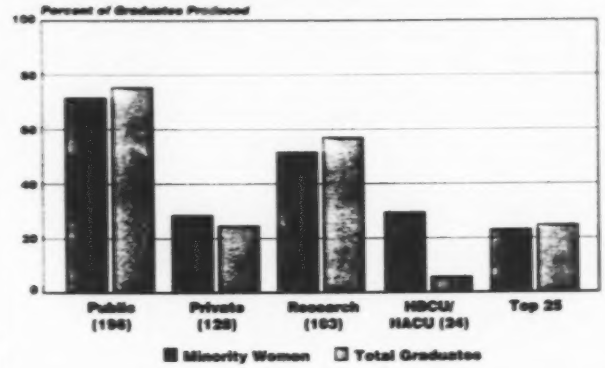


Figure 20.

Minority v. Nonminority First Year Women

Top 50 Ranked Engineering Schools

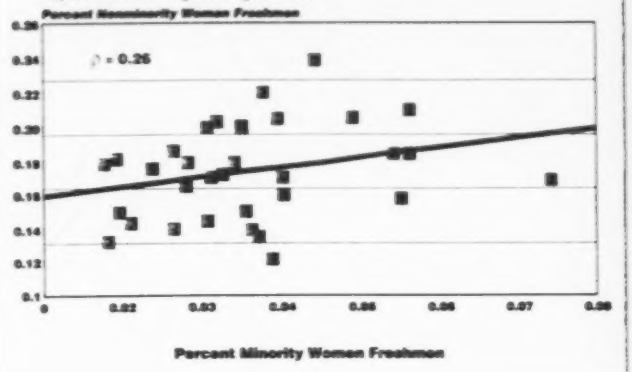


Figure 21.

Minority Freshmen: Women v. Men

Top 50 Ranked Engineering Schools

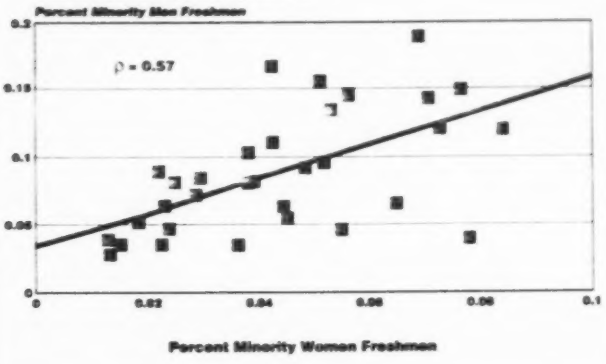


Figure 22.

Retention in Engineering

Class of 1994

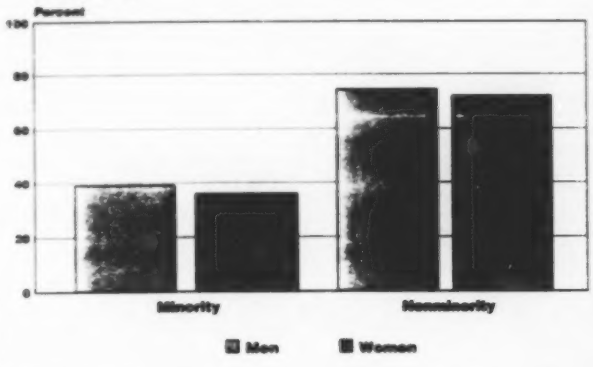


Figure 23.

Financial Aid Trends

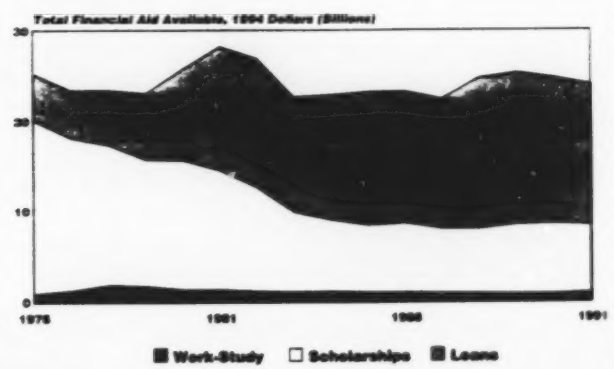
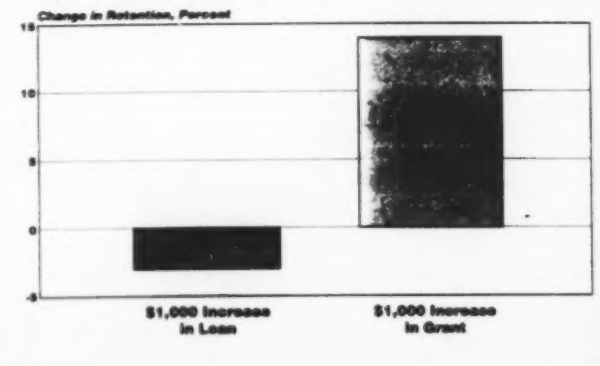


Figure 24.

Loans v. Scholarships

Impact on Retention: Low Income Students



equity, minority women generally identify more strongly with racial or ethnic issues than with gender issues, and that they appear better supported by minority programs than by women's programs.

Retention

The greatest opportunity we have to increase the participation of minorities, including minority women, in engineering is to improve retention in undergraduate degree programs. We estimate that the retention of minority women, nationally, in the class of 1994, was only 36 percent, half that of nonminority women and eight percent less than that of minority men (Figure 22). Many programs and strategies have emerged over the past 15 years to address the problem of minority retention in engineering and, though a few institutions have had some success, on a national level there has been little progress. Most programs have focused almost exclusively on students and their presumed lack of preparation or skills. Academic preparation is certainly one of the issues, since minority students, on average, attend high schools with fewer qualified mathematics and science teachers, less demanding curricula, lower expectations, etc. However, it is by no means the only issue, and, perhaps, is not even the most critical problem. Engineering loses many minority women students who are doing quite well academically. Unfortunately, very little attention has been paid to institutional factors that induce attrition: unmet financial need, faculty attitudes toward minority women, both ethnic and gender isolation, the absence of natural mentors, lack of peer support, isolation from the social mainstream of academic life, and outdated pedagogy, learning theory, curriculum and instructional delivery methods. Some of these factors, of course, are not unique to minority women or any other population group; however, as before, they tend to have a disproportionate impact on minorities because of the other institutional biases that are present.

Financial Aid Policy

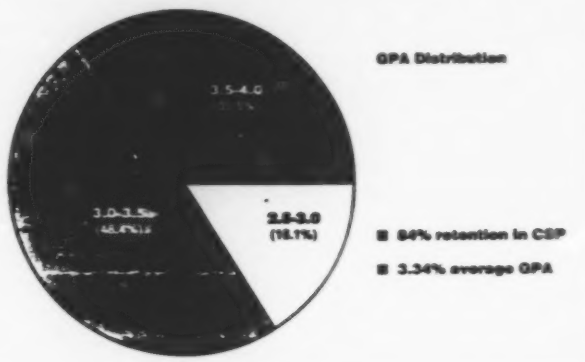
The financial need issue is particularly important. Over the past 15 years, the cost of higher education has grown faster than health care and twice as fast as family income.[9] In addition, financial aid policies have shifted dramatically in favor of middle to upper income families. Aid packages have gone from predominantly scholarships and grants to mostly loans, particularly for poor students (Figure 23).[10] That is, scholarships are being used by universities more as a recruitment tool to attract upper economic class students whose families can pay the discounted tuition directly in cash, and perhaps even express their gratitude with a tax-deductible contribution. With the current attacks and consequent withdrawal from affirmative action programs, including minority scholarships, these policies have subtly created an affirmative action program for the wealthy. Students with lower qualifications, but who are affluent, are offered scholarships in order to improve the university's net tuition revenues and cash flow. While the objective of this process is not to create bias against minorities or poor students, the net effect is reduced access and *de facto* discrimination. Another policy that negatively impacts minority students is the so-called bait and switch strategy, where students are offered a more attractive package as freshmen than in later years. A recent study by the General Accounting Office of the federal government shows the tremendous impact of such a strategy. Shifting a mere $1,000 from scholarship to loan dollars results in a 17 percent drop in retention (Figure 24).[11]

NACME has provided more than $50 million in financial aid to minority students since 1980, and our experience shows that, when minority students are provided with equitable financial aid, along with the kind of institutional support their peers enjoy — either from inside the university or externally supplied — not only are their retention rates comparable or better, but they achieve at comparable or higher levels academically as well. This is notable because these students disproportionately have high school experiences in mathematics and science that are substandard relative to the typical engineering student. Our flagship Corporate Scholars Program (CSP), which currently includes 44 percent minority women, provides substantial financial support, corporate mentors trained by NACME, academic and leadership development workshops and institutional intervention when necessary. The retention rate for CSP Scholars is 84 percent; 36 percent of the students have grade point averages higher than 3.5 upon graduation; and the overall grade point average is higher than 3.3 (Figure 25). It's important to point out that these results are not achieved simply through the selection process. Student profiles upon admission to the program would not predict these outcomes.

Conclusions and Recommendations

We've seen that engineering, together with physics, persists as the most exclusive male domain among the science-based disciplines and that minority women remain the most underrepresented group, a manifestation of the double-bind of racial and gender discrimination. Constituting 15 percent of the college-age population, minority women comprised only 2.2 percent of the bachelor's graduates in 1994 and a mere 0.3 percent of the Ph.D.s. In addition, freshman enrollment of minority women declined 12.1 percent between 1992 and 1994 — 15.9 percent for African American women. Major inhibiting factors begin very early in their precollege educational experience and few graduate from high school with the necessary prerequisites to pursue engineering in college. High school enrollments in academic mathematics and science, are significant factors in the gap between minority and nonminority engineering enrollment. However, high school course enrollments, with the exception of physics, and academic performance in mathematics and science are comparable for boys and girls and are insufficient to account for the gender gap at the

Figure 25.
Corporate Scholars Program Graduates



university level. Other socialization processes are at work inside and outside of classrooms.

Those minority women who acquire a high quality precollege education and perform well in mathematics and science disproportionately opt out of the pipeline before entering college. Those who go on to major in engineering have the highest attrition rate compared to peers from other ethnic and/or gender population groups.

Failure to solve the attrition problem stems, in part, from an overemphasis on the student deficit model and underemphasis on institutional deficiences. Historically, programs aimed at increasing access to science and engineering careers for minorities and women have focused almost exclusively on changing the attributes of those who have traditionally been excluded. Very little attention has been directed inwardly, at conscious efforts to identify, examine, understand and eliminate barriers for minorities and for women that arise from institutional cultures and practices.

In addition, social science research and practice have neglected the unique issues faced by minority women and these issues typically have not been addressed in programs aimed at increasing access to engineering. Ongoing research at NACME is examining university characteristics and attributes that are highly correlated with success of women, particularly minority women, in engineering, where success is defined as high enrollment coupled with high retention, academic performance and, ultimately, satisfying career paths. Quantitative and qualitative institutional factors might include the school's student population distribution by race and gender, range of engineering subdisciplines offered, prestige (ranking, research status) of the institution, leadership characteristics, attention to undergraduate education, history and tradition with respect to minorities, local and regional demographics, type and quality of outreach and support programs, and financial aid policies.

There is, of course, a real danger in creating more and more narrow subdivisions of special interest groups. But, at 15 percent of the college-age population, African American, Latino and American Indian women together comprise a sizable minority. Moreover, it's essential to recognize, both philosophically and strategically, that serving the needs of specific groups, however they're subdivided, is not antithetical to serving the needs of the whole. Many of the institutional barriers identified as clear impediments for women and minorities, are also, in the final analysis, major limitations for all students. Lack of diversity is, itself, a constraint on the engineering profession. There are well-established and compelling examples from the annals of science on the value of diversity. The presence of women in biomedical research has contributed substantially to the exploration and understanding of gender differences in the character of and in the response to disease. The arrival of women in anthropology has led to significant revision in theories of primate social behavior.

The most important recommendation we offer is that, in the reform process, universities must balance the current emphasis on the victims of discrimination and exclusion with greater attention to transforming institutional cultures and practices. This means that there must be unequivocal, unabashed commitment and leadership on the issue of diversity. Universities should consider faculty and student workshops on understanding and valuing ethnic and gender differences and on communicating effectively across ethnic and gender boundaries. Training could be offered to ensure that faculty members have the skills to manage classes and group learning processes where there are diverse populations. Finally, the university must examine its financial aid policies and strategies and determine the implications for minority access. The most effective institutional reform tactics will not be directed toward creating opportunities for some groups at the *expense* of others, thereby intensifying inter-group conflict. They will, instead, offer improved educational development practices and greater opportunities to learn for all students, which, in a society characterized by diversity, inevitably means a more equitable and more inclusive environment.

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Footnotes

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